Meroë.

Cult.	Magnetic Azimuth.	Astronomical Amplitude.	Decl.
Pyramid 16	N. 102° E.	3½° S. of E.	S. 3¼°
Pyramid 20	N. 103 E.	4½ S. of E.	S. 4¼
Temple near Wasser Becken	N. 112 E.	13½ S. of E.	S. 12¾
Pyramid 15	N. 112 E.	13½ S. of E.	S. 12¾
Pyramids 14, 37 ...	N. 113 E.	14½ S. of E.	S. 13¾
Pyramid 10	N. 116 E.	17½ S. of E.	S. 16¾
Pyramid 39	N. 118 E.	19½ S. of E.	S. 18¾
Pyramid 19	N. 83 E.	15½ N. of E.	N. 14¾

Nuri.[2]

Cult.	Magnetic Azimuth.	Astronomical Amplitude.	Decl.
Pyramids 10, 11, 12	N. 136° E.	37½° S. of E.	S. 35¼°
Pyramids 1, 4 ...	N. 137¼ E.	38¾ S. of E.	S. 36¼
Pyramids 13, 14, 15	N. 139 E.	40½ S. of E.	S. 38
Pyramids 2, 3, 16, 17	N. 145½ E.	47 S. of E.	S. 43¾
Pyramids 5, 6, 7, 8, 9	N. 146½ E.	48 S. of E.	S. 44¾

Gebel Barkal.[3]

Cult.	Magnetic Azimuth.	Astronomical Amplitude.	Decl.
Temple E	N. 132° E.	33½° S. of E.	S. 31½°
Pyramid 18	N. 132½ E.	34 S. of E.	S. 32
Temple L	N. 136½ E.	38 S. of E.	S. 35½
Pyramids 9, 13 ...	N. 136 E.	37½ S. of E.	S. 35¼
Pyramid 11	N. 140 E.	41½ S. of E.	S. 39
Pyramid 1, 2	N. 141 E.	42½ S. of E.	S. 39¾
Temples J and H ..	N. 146 E.	47½ S. of E.	S. 44¼
Pyramid 20	N. 146 E.	47½ S. of E.	S. 44¼
Pyramids 2, 15, 16, 17	N. 147 E.	48½ S. of E.	S. 45¼
Temple B...	N. 152 E.	53½ S. of E.	S. 49¾
Pyramids 5, 6, 7, 8, 10	N. 153 E.	54½ S. of E.	S. 50½
Pyramid 19	N. 156 E.	57½ S. of E.	S. 53
Temple A	N. 170 W.	88½ S. of W.	S. 71¼

It seems quite justifiable from the above facts to conclude that the pyramids and temples oriented S.E. and, as I hold, to *α* Centauri when it heralded the autumnal equinox, were not built by people having the same astronomical ideas, worships, and mythology as those who built at Gizeh due E. and W., and marked the autumnal equinox by the heliacal rising of Antares.[4] The only thing in common was noting an equinox, and so far as this goes we may infer that neither people dwelt originally in the Nile Valley, but came by devious ways from a country or countries where the equinoxes had been made out.

J. NORMAN LOCKYER.

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[1] For plans see "Lepsius," vol. ii. 133 and 134. A west variation of 8½° has been assumed.

[2] For plans see "Lepsius," vol. ii. 130. A west variation of 8½° has been assumed.

[3] For plans see "Lepsius," vol. ii. 125 and 127. A west variation of 8½° has been assumed.

[4] There is a point of great interest here. It would seem from Captain Lyons' examination of the temples at Wady Halfa, which I make out to have been oriented to *α* Centauri, that when the two races were amalgamated in later times, both the stars to which I have referred as heralding the equinox were personified by the same goddess Selk.

APPARATUS ILLUSTRATING MICHELSON'S METHOD OF OBTAINING INTERFERENCE BANDS.

IN the *American Journal of Science* for August, 1881, Captain Michelson described an ingenious method for producing interference bands, used by him in determining the relative motion of the earth and the luminiferous ether. Light from a lamp at *a* falls on a thinly silvered mirror *b*, where it divides into two rays—one, *b c*, reflected from the thinly silvered surface, is reflected back to *b* by the plane mirror *c*; the other ray traverses the glass plate *b*, and falls on the plane mirror *d*, whence it is reflected back to *b*. Here both rays reunite, and pass onward toward *e*. The mirrors *d* and *c* are silvered and polished on their front surfaces. By this means bands, similar to Newton's rings, are obtained between the mirror *c* and the reflection of *d* in *b*; the retardation of one ray with respect to the other being the length *bc-bd*; *f* is an unsilvered piece of plane glass, cut from the same piece as *b*, and placed in the ray *b c*, so as to compensate for the ray *b d* passing twice through *b*; otherwise, owing to the dispersive power of the glass in *b* different wave-lengths of light in the ray *b d* would be unequally retarded in comparison with the same wave-lengths in the ray *b c*. If the path *b c* be now equalised in length with the path *b d*, and if, moreover, the piece of glass *f* be exactly equal and parallel with *b*, the central band will be black, owing to the ray *d b* being reflected from the rarer medium, whilst *a b* is reflected from the denser medium.

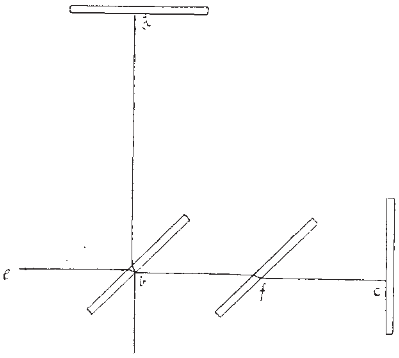

FIG. 1.

Apparatus to show these bands can be easily and cheaply set up, and owing to the fact that an extended source of light may be used, they can easily be projected, and thus many interesting experiments shown to a large audience. The following is a description of a simple construction of the apparatus which I have found to work admirably.

All the parts are mounted on a piece of plate-glass ½″ × 9″ × 12″. The two mirrors *d* and *c*, each two inches square, were silvered by the milk-sugar process, and afterwards polished with washleather and rouge in the ordinary manner. The mirror *b* was withdrawn from the silvering solution when only a thin layer had been deposited; no polishing was necessary. The layer of silver should reflect considerably more than half the light incident upon it, as thus the reflections from the unsilvered surface of *b* become relatively insignificant. Ordinary plate-glass was used in each instance.

Each mirror was attached vertically by pitch to a stand composed of two pieces of band brass soldered together at right angles, having three feet *a*, *b*, *c* (Fig. 2). In the case of the glasses *b*, *f*, and *c* (Fig. 1), a screw of pitch $\frac{1}{20}$″ was inserted in *c* (Fig. 2) as a rough adjustment for verticality of the mirror.

The mirrors *b* and *f* were maintained in position[1] by the conical foot *a* (Fig. 2) standing in a cylindrical hole in a blank which was stuck to the glass bed-plate by pitch, *b* resting simply on the surface of the glass, whilst the foot *c* stood in a V-groove in a brass blank, also stuck by pitch to the glass bed-plate. The fine adjustments required are for *c* (Fig. 1) a motion in the direction *c f*, and for *d*, adjustments in altitude and azimuth. These were respectively obtained by placing the two feet *b* and *c* (Fig. 2) (which should be rounded) of the mirror *c* (Fig. 1) in a long V-groove (a piece of angle brass was used), the third foot resting on the glass surface; the foot *c* was held against a screw passing, in the direction of the groove, through a brass blank soldered at the end thereof, which gave the longitudinal motion required for that mirror. By means of a lever of 18″ or so in length attached to it, a piece of steel wire, with a thread cut by means of stocks and dies of 40 to the inch, was found capable of adjusting to a quarter of a wave-length of light. The adjustments of the remaining mirror *d* (Fig. 1) were obtained by allowing the conical foot *a* (Fig. 2) to rest in a cylindrical hole, whilst the foot *b* rested on the glass as in the mirrors *b* and *f* (Fig. 1). The leg *c* (Fig. 2) was formed of a piece of steel wire with a screw thread cut as described above, with a large brass blank soldered to its upper end; this gave the adjustment in altitude. The adjustment in azimuth was obtained by holding the horizontal piece of band brass *b c* by means of a piece of elastic against the end of a screw of similar pitch to that last described, passing through a vertical pillar attached to the base-plate. The whole arrangement is shown in Fig. 3.

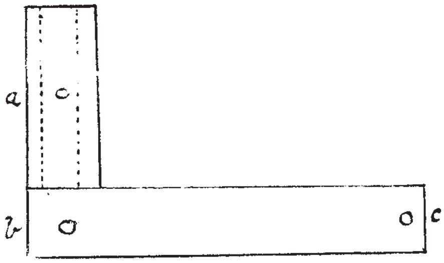

Fig. 2.—The dotted lines indicate the position of the mirror.

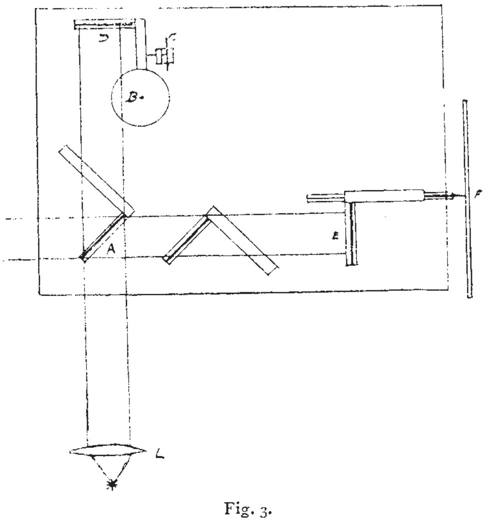

Fig. 3.

To avoid the effect of vibrations the whole may be supported on a block of stone, resting, in its turn, on hollow india-rubber balls; a plan adopted successfully by Dr. O. Lodge. When mounted in this manner the bands may be shown in a room possessing only an ordinary wooden flooring.

The bands are obtained as follows: A bat's-wing burner, or other source of white light, is placed at the focus of the lens L (Fig. 3) and arranged so as to illumine the mirror A. A card with a pinhole in it is then placed in front of the lens L, and, on looking in the direction M A, two images of this will be seen. By means of the screws B and C these two images are superimposed; and the distance A E having been adjusted by means of the screw and lever F and a steel scale, to be equal to A D, a sodium flame is placed in the focus of L and the pinhole card removed; the sodium bands will at once appear. By means of the screws B and C these are adjusted to a convenient width, and then, the bat's-wing burner having been replaced in the focus of L, the lever F is turned very slowly till the coloured bands appear. This can be done much more easily by placing a piece of platinum wire holding some sodium into the flame, when the bands due to the sodium will be faintly outlined on the white background, thus giving a guide as to whether or no you are turning the screw F too fast. The bands appear on the surface of the mirror E, and if an electric arc or a mixed gas limelight jet be substituted as the source of light, they can be projected on a screen so as to be visible to a large audience.

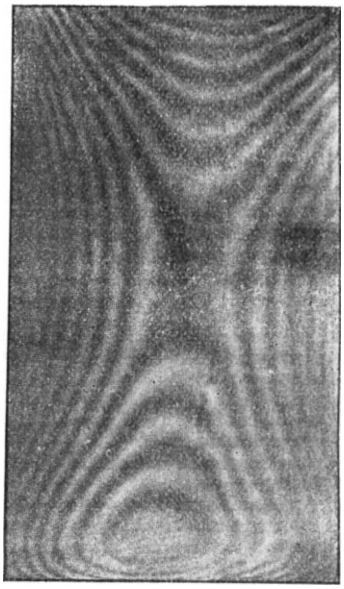

Fig. 4.—Photograph of interference band showing *cold* match.

The forms of these interference bands, supposing each of the four pieces of glass to be perfectly plane and parallel, is given by Michelson (*Phil. Mag.* April 1882). The peculiar form of the bands obtained in my apparatus is shown in Fig. 4; this form is due to the curvature of the surfaces of the various glasses. A thin piece of glass or a soap film may be introduced into one of the paths and the displacement of the bands exhibited. But perhaps the prettiest experiment is to introduce the glowing end of a match into one of the rays. Suppose this ray to be A E (Fig. 3); then the appearance presented is exhibited in Fig. 5, where the bands are seen to curve round the end of the match as if it were pushing them inwards. A cold body, such as a piece of copper wire, cooled in a freezing mixture, has an opposite effect, attracting the bands into it. These effects are, of course, due to the heating or cooling of the air near the hot or cold body. Now it will be found on slowly turning the screw F (Fig. 3) so as to shorten the path A E that the bands at the side move in toward the centre, the opposite being the case on lengthening the path A E. Therefore heating the air (*i.e.* rendering it less dense) has the same effect as shortening the path (*i.e.* it accelerates the motion of the light passing along it), whilst cooling the air (rendering it denser) has the opposite effect; which demonstrates very simply the truth of the undulatory as opposed to the emission theory of light; for on the latter theory the exact reverse would be the case.

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[1] For some remarks on the general principles of these "geometrical slides" and "clamps," see Thomson and Tait's "Nat. Philosophy," part i. p. 150.

EDWIN EDSER.

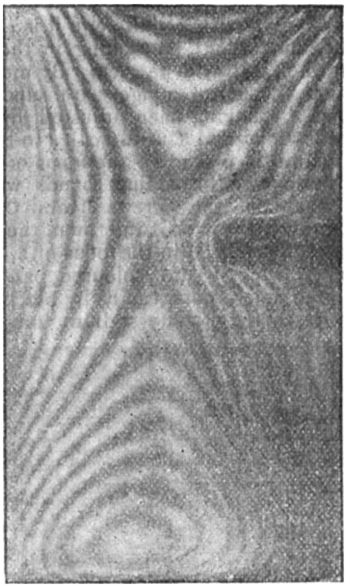

Fig. 5.—Photograph of interference bands showing effect of introducing glowing end of match.

THE AUGUST METEORS, 1893.

THE Perseid shower, though it cannot rival periodical displays such as the November Leonids and Andromedes when at their best, is certainly of equal interest, for it forms a tolerably rich display every year, and continues active during several weeks from a radiant which has a comet-like motion of about 1° R.A. per day eastwards. A vast number of observations have been made during the last half-century, but it must be confessed that we have by no means completed our investigation of this remarkable stream. Nor have we gained a thorough knowledge of the numerous and fairly prominent minor showers which contribute to render this epoch the most significant and the most interesting period of the year to the meteoric observer.

Either moonlight, or cloudy wet weather, prevented my obtaining any observations at the latter part of July this year, and it was not until August 4 that I commenced work. Moonlight was, however, pretty strong, and in a watch of about half an hour I only saw four meteors, including one typical Perseid from a radiant at about 36° + 56°.

On the following night, August 5, the sky was much clouded, but between 10h. 15m. and 11h. 45m. I saw, in clear spaces, twelve meteors, of which four were Perseids, indicating a radiant at 39° + 55°. The brightest meteor seen was at 11h. 3m., but it appeared behind thin cloud in the northern sky. It was fully equal to a 1st mag. star, and left a bright streak along its path from 17½° + 76° to 219° + 78°. This was not a Perseid, the direction of flight being from near γ Andromedæ.

The nights of August 6 and 7 were cloudy and no observations could be secured.

On August 8 the sky cleared and I counted 36 meteors in the two hours from 10h. 50m. to 12h. 50m. There were 12 Perseids amongst them and the radiant was well defined at 41° + 56°. At 11h. 25m. a fine Perseid about equal to Jupiter flashed out in the region of Polaris and left a streak of nearly 20 degrees along its course.

August 9 proved fine, but lightning was extremely frequent and vivid during the whole night, and considerably interfered with the observations. It proceeded from clouds low in the east and north quarters, but apart from that the firmament was very clear. The day had been one of excessive heat, the maximum shade temperature being 84°; the lightning which followed it may be said to have been in constant play during the night, one flash succeeding another with little intermission. The effect as it burst through the broken clouds and lit up their borders was very beautiful and so striking as to distract attention from the far less imposing features of the meteor shower then in progress. In the 2½ hours' interval between 11h. 30m. and 14h. I managed, however, to observe 45 meteors, including 20 Perseids from a radiant which I determined as follows:—

h. m.		h. m.		°		
11 30	to	12 0	...	42 + 56	...	4 meteors.
12 0	to	13 0	...	43 + 57	...	9 ,,
13 0	to	14 0	...	43 + 57	...	7 ,,

Adopting the mean centre as at 43° + 57°, I think the position may be considered a very accurate one for the date. I saw no exceptionally brilliant meteors during the night, though several of the 1st mag. were recorded, and the Perseids struck me as being fainter than usual. Most of them traversed swift short paths not very far from the radiant, so that the position of it could be determined very satisfactorily Mr. Booth of Leeds informs me that he found the Perseid radiant at 43° + 57° from 15 meteors of this shower observed on August 9. This position is identical with that found at Bristol on the same night.

On August 10 the sky proved variable, but it was pretty clear at times before midnight and overcast afterwards. Between 11h. and 12h. I noticed 21 meteors, of which 14, or two-thirds of the whole, were Perseids, but clouds interrupted work during a part of the time. After 12h. it was not found possible to continue the work with any further prospect of success, as clouds had obliterated all but a few 1st mag. stars. The Perseid radiant was now found at 45° + 57°, which agrees with the usual position on the date of maximum. As to the character of the radiation on this and previous nights, it was fairly definite and exact, and limited to an area of 2° or 3°. In point of activity I regarded the shower as disappointing on the 5th, 8th, and 9th, but from what I saw on the 10th, and considering the unfavourable circumstances prevailing at the time, the display was a tolerably conspicuous one. I recorded several bright meteors on the 10th, and, as they may possibly have been seen elsewhere, the times of apparition and observed paths are given below:—

	Mag.	From α δ	To α δ	Radiant.	Notes.
h. m.		° °	° °		
11 0	1	1+11	26+19	304−14	Slow.
11 21	1	331+38½	317+23½	Perseid	Swift, streak.
11 24	1	325+29	314+15	Perseid	Swift, streak.
11 43	♀	42+55	40+53½	Perseid	Slow, b. streak.
11 56	♃	140+84½	200+70	Perseid	Swift, streak.

On August 11 the sky was overcast.

On August 12 it was partly fine before 13h., but by no means favourable for this class of work. I counted 24 meteors, including 7 Perseids with radiant at 48°+57°.

On August 13 the conditions had greatly improved, and after midnight there was not a cloud in the sky. Watching for 3½ hours I recorded 43 meteors and found the Perseid shower still visible from a radiant at 48°+57° (8 meteors). No exceptionally bright meteors were seen, but at 13h. 5m. one about equal to Jupiter fell from